

### Description

The invention concerns a method of manufacturing a plasterboard lined with coated glass fiber, in which a sheet of coated glass fiber is provided which is formed by a glass fiber layer and a dry coating mass forming a coating and penetrating the glass fiber, and in which the horizontally advancing sheet of coated glass fiber is provided on the uncoated side with a strand of hardenable gypsum core mass which penetrates the glass fiber and forms a hardenable board core thereon, wherein the hardenable gypsum core mass penetrating the glass fiber has a preset pasty consistency when it flows onto the sheet, and the coated glass fiber forms two peripheral strips lying in the sheet plane, and wherein, in the finished plasterboard, the coating with the glass fiber is held on the board core over the whole board plane with a peeling strength measured at right angles to the board plane.

Moreover, the invention concerns a plasterboard according to the Preamble of Claim 8, manufactured according to the method described above. The plasterboard is unprocessed and the coating mass has specific setting properties.

A method of this type is known (DE-OS 20 08 744) with the exception that the coated glass fiber is formed by a glass fiber layer and a peelable paper coating. However, it is also known (DE-OS 39 37 433) to manufacture a plasterboard provided with a coated glass fiber layer which is formed by a glass fiber layer and a dry coating mass forming, for example, a coating and penetrating the glass fiber. The plasterboard manufactured according to this method has an advantage because the surface of the plasterboard does not require subsequent priming and the surface of the finished plasterboard can be immediately lined with latex paint, wall paper, tiles or plates. Advantageously, the glass fiber coated with the dry coating mass is dry when provided with a strand of the hardenable gypsum core mass and cannot contaminate the production facility with gypsum core mass because gypsum core mass cannot penetrate the glass fiber.

The known methods of this type (DE-OS 20 08 744, DE-OS 39 37 433) mentioned at the outset do not indicate that the gypsum core mass penetrating the glass fiber before hardening is brought into contact with the coating mass permeating the glass fiber. If a plasterboard manufactured according to the method mentioned at the outset is to be of practical use, it is important that the composite material from coating to board core is of high quality. The quality of the composite material is characterized by its peeling strength which specifies the force/area required to pull at a measuring disc glued to a coating until the composite material is destroyed. Based on tests performed with a plasterboard manufactured according to the type mentioned at the outset, a peeling strength of  $0.1 \text{ N/mm}^2$  is not sufficient for a practical use of the plasterboard. In particular, this results in delamination or interior decomposition of the glass fiber layer, which is of considerable disadvantage when attaching heavy coatings, such as heavy wall paper or textile finishing or ceramic tiles. In order to repair the damage it is necessary to prime the surface with a suitable primer of thin consistency so that the primer can deeply penetrate the fiber to strengthen the surface and improve the bond with the gypsum core mass. This requires an additional cost-intensive working process at the construction site.

One objective of the invention is, therefore, to provide a method of the type mentioned at the outset which supplies maximum contact between the hardenable gypsum core mass penetrating the glass fiber and the dry coating mass permeating the glass fiber. With the objective of solving this problem, the invention-based method is characterized in that the pasty consistency of the hardenable gypsum core mass is set to a spreading diameter of at least 240 mm and at most 320 mm, wherein the spreading diameter is that of a gypsum core mass accumulation resulting from a truncated cone of hardenable gypsum core mass of natural gypsum after dropping 200 mm or of gypsum from flue gas desulphurization after dropping 125 mm, the truncated cone having a larger diameter of 101 mm, a height of 80 mm and a smaller diameter of 80 mm, and the drop taking place 15 sec. After flowing towards the sheet, and in that, at at least two vibration points spaced apart in the feed direction, the coated glass fiber provided with the strand of hardenable gypsum core mass is vibrated transversely over the board plane of the glass fiber until the core mass and the coating mass are brought into contact with one another so that the peeling strength of the finished plasterboard is at least  $0.15 \text{ N/mm}^2$ .

The invention-based method achieves an almost continuous, uninterrupted laminar contact between the dry coating mass permeating the glass fiber and the gypsum core mass penetrating the glass fiber. This depends on the vibration methods which, in turn, provide an equal distribution of the strands of hardenable gypsum core mass supplied. At the important peripheral strips of the glass fiber, the process of gypsum core mass penetrating the glass fiber has been improved. Because of the vibration methods, the pasty consistency of the gypsum core mass can be maintained at a spreading diameter of at most 320 mm. As a result, only a relatively small amount of excessive water needs to be removed later from the gypsum core mass.

In the context of the invention, the desired peeling strength of at least  $0.15 \text{ N/mm}^2$  is also produced in the peripheral strips, for which purpose special methods have been provided. As a result, the plasterboard manufactured according to the invention has an excellent level of edge strength. Because the hardenable gypsum core mass is vibrated transversely over the whole breadth of sheet plane, in most cases the edges are properly shaped, achieving the desired peeling strength even in the peripheral strips.

An advantageous embodiment is available if the strand of hardenable gypsum core mass is applied by paste being fed onto the sheet plane from a main mixer via a central outlet and from an edge mixer via a respective lateral outlet in the region of the two peripheral strips. The additional amount of core mass or paste being applied to the peripheral strips has the effect that even the first transverse vibration applies the gypsum core mass to the regions of the peripheral strips of the glass fiber to the extent that a peeling strength of at least  $0.15 \text{ N/mm}^2$  is achieved.

In this case, the plasterboard production facility has a molding station consisting of a main mixer and an edge mixer. For example, the main mixer produces gypsum of pasty consistency from plaster of Paris, water, foaming agents and additives. Said gypsum flows from the central outlet of the main mixer onto the sheet plane formed by the coated

glass fiber. A portion of the gypsum paste is diverted from the main mixer and supplied to the edge mixer. In the edge mixer, the foam is basically disintegrated. The gypsum paste thus modified in the edge mixer has higher density and higher stability than the gypsum paste in the main mixer. Via thin outlet hoses, it is directly fed onto the edge regions of the peripheral strips, covering a breadth of app. 6-12 cm.

However, it is also especially practical and advantageous if at a subsequent vibration point, the two peripheral strips of the coated glass fiber lying in the sheet plane are additionally vibrated. If at the two transverse vibration points the gypsum core mass at the edge regions has not penetrated the glass fiber deep enough, this deep penetration will be achieved by the peripheral strip vibrations.

A further practical embodiment is achieved if the strand of hardenable gypsum core mass is covered from above with an upper sheet of coated glass fiber formed by a glass fiber layer and a dry coating mass forming a coating and penetrating the glass fiber, and if the upper glass fiber layer is vibrated transversely over the sheet plane of the upper glass fiber layer at at least one upper vibration point. In this simple way it is guaranteed that even an upper glass fiber layer adheres to the remaining plasterboard at each point over the whole sheet plane with a peeling strength of at least  $0.15 \text{ N/mm}^2$ , measured at right angles to the board plane. As a result, no additional measures are required for the peripheral strips.

At the at least two lower, transversely extending vibration points, for example, two unconnected, rod-like transverse vibrations can be provided, or a single mutual transverse vibration in the form of a longitudinal table. Even the upper vibration point can be designed as a transverse vibration having the form of a rod or a longitudinal table. The vibration can be produced by means of rotating polygon-shaped irons applying vibration on the coated glass fiber or by means of a vibrating plate.

An especially practical and advantageous embodiment of the invention is achieved if, on the underside of the sheet of coated glass fiber, air is sucked from the region of the glass fiber layer free of coating mass transversely over the sheet. Through the porous coating mass, air is sucked from the pores of the glass fiber so that it is easier for the gypsum core mass to penetrate.

Usually, the sheet of coated glass fiber forms transition regions projecting beyond the peripheral strips and subsequently bent upwards along the peripheral strips through a bending angle by means of a guide rail in order to prevent the relatively liquidly gypsum core mass from running out at the sides. The bending angle in the region of vibration amounts, for example, to  $30^\circ$ . It is also especially practical and advantageous if the sheet of coated glass fiber forms transition regions projecting beyond the peripheral strips which subsequently are bent upwards along the peripheral strips through a bending angle by means of a guide rail, and if bending upwards takes place through  $90^\circ$  in the region of the lower, transversely extending vibration points. In this way the gypsum core mass is exposed to the vibration effect even in the region of the peripheral strips because it cannot flow, for example, over the transition regions.

In the plasterboard manufactured according to the invention, the core mass and the coating mass in the glass fiber layer have almost continuous contact over the whole plane. The separation plane between the core mass region and the coating mass region is partially formed by glass fiber. As a result, no contact between core mass and coating mass takes place in these planar regions. Moreover, during the drying period, the gypsum body of the core mass has a porous texture because of the usual addition of air-entraining agents and the evaporation of mixing water. In this respect, it is not practical to indicate the extent of contact between core mass and coating mass through proportions of a separation plane between the core mass region and the coating mass region. Therefore the extent of contact is characterized by the peeling strength.

In the plasterboard, the core mass has such a laminar contact with the coating mass that the interior stability of the system demonstrated by the peeling strength amounts to at least  $0.15 \text{ N/mm}^2$  at each point. It is especially practical and advantageous if the pasty consistency is set and vibrated in such a way that it results in a medium peeling strength of at least  $0.2 \text{ N/mm}^2$ . With these limit values of peeling strength, the invention produces the most favorable results in practice.

The hardenable core mass consists of calcium sulfate hemihydrate, water, additives and liquefiers. The consistency of the gypsum paste is adjusted, for example, by varying the water-gypsum proportion and/or by adding liquefiers, retarder and/or activators. The pasty consistency provided by the invention-based method is not restricted to the measuring method provided or to the calculation parameter "spreading diameter", but it can also be determined by different measuring methods, or it can be depicted by different calculation parameters. It is important that, in this context, the pasty consistency involves the gypsum core mass here applied to the sheet, and that the calculation parameter is determined within a specific maximum time span after the gypsum core mass has been extracted for testing.

The invention-based method can basically be performed with all suitable coating masses, as they are indicated, for example, in DE-OS 39 37 433. The invention-based design of the plasterboard results in the fact that glass fiber abrasion can be almost completely avoided at the places of processing. The coating mass is ductile and hard and does not release any glass fiber. Since the core mass has an almost continuous laminar contact with the coating mass, all glass fiber is surrounded by the mass. Because of its practically non-abrasive surface, the new plasterboard is also suitable for coating ventilation shafts and cable channels. Because of the improved peeling strength, it is possible to indicate at each point of the gypsum coating the extent to which the core mass penetrates the glass fiber layer or the core mass is applied to the coating mass. The invention-based plasterboard also has excellent coating characteristics so that even heavy coating materials form a permanent and stable connection with the plate without requiring prior priming or any other extensive treatment of the surface.

Independent of how deep the coating mass has penetrated the glass fiber layer, provision has been made that the core mass has penetrated the glass fiber layer deep enough so that

the desired continuous contact between coating mass and core mass has been achieved. In this way also the peeling strength is improved, thus reducing the danger of disrupting the glass fiber layer. It is actually a known method (GB-OS 2 053 779) to manufacture a plasterboard in such a way that the core mass penetrates the glass fiber layer to a greater or lesser extent. In the invention-based plasterboard, the core mass penetrates the glass fiber layer to the extent that it comes in continuous contact with coating mass that has penetrated the glass fiber layer before.

The quality of the composite material is especially increased in that the calcium sulfate of the coating mass is used as a nucleating agent of the core mass. In this way, an epitaxial growth of a gypsum layer occurs at the connection between the core mass and the coating which considerably improves the adhesive strength of the composite material.

In the context of the invention, the slow setting speed is usually provided if the coating mass takes at least 1.5 hours to begin to harden according to DIN 1168 and a maximum of 6 hours to begin to harden. It is especially practical and advantageous if the coating mass takes at least 2.5 hours to begin to harden and/or a maximum of 5 hours to begin to harden. In this setting-time range, the invention has an especially excellent performance in practice.

The calcium sulfate of the non-processed plasterboard is available in unset or barely set condition: the rehydration level of the coating mass is  $<5\%$ , i.e., a maximum of 5% of the calcium sulfate initially provided for the mixing process is formed into calcium sulfate dihydrate. However, usually the calcium sulfate of the coating mass is not hardened, except for a rehydration degree of at most 2%.

In the plasterboard, the core mass and the coating in the glass fiber layer have almost continuous contact over the whole plane. The separation plane between the core mass region and the coating mass region is partially formed by glass fiber. As a result, no contact between core mass and coating mass takes place in these planar regions. Moreover, during the drying period, the gypsum body of the core mass has a porous texture because of the usual addition of air-entraining agents and the evaporation of mixing water. In this respect, it is not practical to indicate the extent of contact between core mass and coating mass through proportions of a separation plane between the core mass region and the coating mass region. Therefore the extent of contact is characterized by the peeling strength.

In the plasterboard, the core mass has such a laminar contact with the coating mass that the interior stability of the system demonstrated by the peeling strength amounts to at least  $0.15 \text{ N/mm}^2$  at each point. It is especially practical and advantageous if the average peeling strength is at least  $0.20 \text{ N/mm}^2$ . With these limit values of peeling strength, the invention-based plate has an especially excellent performance in practice.

It is also especially practical and advantageous if the coating mass consists of calcium sulfate hemihydrate and contains additives, effecting a slow setting speed of the calcium

sulfate hemihydrate. Adding additives to the calcium sulfate hemihydrate has the effect that the coating mass of the plasterboard remains unset or barely set.

Usually the calcium sulfate hemihydrate consists of baked plaster of Paris. For the slow setting speed it is required to add additives in the form of retarder. A suitable retarder is, for example, citric acid and protein hydrolyzate.

It is also especially practical and advantageous if, independent of the water to be added, the coating mass has the following composition when mixed: 60% - 95% by weight of plaster of Paris, 0.01% - 1% by weight of cellulose ether, 0.03% - 0.5% by weight of retarder, 0.05% - 1.0% by weight of liquefier. In this regard, it is especially advantageous if the coating mass contains up to 25% by weight of limestone powder and/or up to 5% by weight of PVAC dispersion. Such a coating mass is especially capable of retaining the glass fiber and has excellent glass fiber abrasion resistance. The limestone powder is filler material. The liquefier is, for example, lignosulfonate, a naphthalene sulfonic acid or a melamine resin.

An especially practical and advantageous embodiment of the invention is the fact that the calcium sulfate is a fine-grained calcium sulfate anhydrite which has a particle size  $< 200 \mu\text{m}$ , preferably  $< 63 \mu\text{m}$  and is partially hardenable. In the case at hand, this specific anhydrite can be provided as gypsum coating of the glass fiber layer. This anhydrite has a very useful power of penetrating the fiber surface and forms an ideal fiber bond consisting of bonding agent and glass fiber. Usually, the anhydrite has an average particle size of  $d_{50}$  between 8 and  $12 \mu\text{m}$ .

In manufacturing the plasterboard, minimal calcium sulfate abrasion occurs when the coated glass fiber layer is placed on the molding station, which accumulates during long periods of production. If the calcium sulfate of the coating mass is anhydrite, the calcium sulfate abrasion does not adhere to the production facility. In this context, it is especially practical and advantageous if, independent of the water to be added, the coating mass has the following composition when mixed: at least 94% by weight of calcium sulfate anhydrite, 0.01% - 0.8% by weight of cellulose ether, 0.01% - 1.0% by weight of liquefier and at most 0.2% by weight of wetting agent. It is especially practical and advantageous if the coating mass contains a plasticizer. The plasticizer is available only in small amounts of, for example, at most 5% by weight and it is, for example, a polyacrylate or a styrene-butadiene. The plasticizer makes the coating mass ductile and flexible, improving its ability to enclose the fibers firmly and permanently.

The organic binder, which is provided in the coating mass in the case at hand, is, for example, polyacrylate or styrene-acrylate. Usually, organic binders deteriorate the burning behavior and increase toxicity of smoke gas developing in case of fire. However, in the invention-based plasterboard, the binder proportion can be kept at a relatively low level. Therefore, it is especially practical and advantageous if the organic binder forms less than 6% by weight of the dry coating mass. The unset or barely set, yet still reactive, calcium sulfate of the coating mass makes it possible that the proportion of organic binder can be reduced.

In a further embodiment, up to 40% by weight aluminum hydroxide or boric acid is added to the coating mass. This guarantees that the plasterboard fulfills the criteria of building materials class A1 according to DIN 4102.

It is also especially practical and advantageous if in the invention-based plasterboard the proportions of the glass fiber layer provided with the calcium sulfate coating are set in such a way that the abrasion on the surface of the coating mass is at most 0.2 g. Such low abrasion exists because organic binders, glass fiber and calcium sulfate form an optimum bonding.

The abrasion resistance is determined according to DIN 53109, "Prüfung von Papier und Pappe: Bestimmung des Abriebs nach dem Reibradverfahren" [Testing of paper and paperboard: Determining the abrasion according to the friction wheel method] and ISO 4586-2 "Abrasion resistance of decorative laminated sheets." The abrasion tester is the Teledyne Taber Standard Abrasion Tester. The standardized sand paper S-33 is applied to the friction wheels. Each friction wheel is loaded with an extra weight of 500g. During testing, the friction wheels with the sand paper S-33 are allowed to impact the sheet surface for 10 rotations. Afterwards the abrasion is measured by determining the difference in weight.

A further advantage of the invention-based plasterboard is the fact that the peeling strength is increased after additional treatment of the surface (base coat, coating, wall paper or plaster application). Sheet planes produced according to the invention have an average peeling strength of  $0.34 \text{ N/mm}^2$ , whereas the minimum value from 6 measurements transversely over the whole breadth of sheet plane, respectively, amounts to  $0.23 \text{ N/mm}^2$ . Part of the sheet planes is coated with a watery latex base coat, the other part is coated with a thin layer of gypsum. The average peeling strength reaches  $0.42 \text{ N/mm}^2$  after priming and  $0.43 \text{ N/mm}^2$  after an application of a thin layer of gypsum: minimum values are increased to 0.24 or  $0.28 \text{ N/mm}^2$ .

The coating mass on the basis of calcium sulfate when mixed as inorganic binder comprises hemihydrate or only anhydrite. The core mass is composed according to the customary method used for plasterboards of the type discussed here and in the way used in customary plasterboards. The invention-based plasterboard is manufactured on customary production facilities for plasterboards. After the production process, the plasterboard is in unprocessed condition, if it is stored and/or transported, and/or mechanically attached. It is in processed condition if the plasterboard is mounted in a structure. If the coating mass of the mounted plasterboard is lined with wall paper, tiles or lamination, it absorbs water and the calcium sulfate is to some extent able to rehydrate.

The drawing shows a preferred embodiment of the invention and shows:

Figure 1 a top view with chippings on a part of a plasterboard having a coated glass fiber layer,

Figure 2 a lateral view of the plasterboard according to Figure 1,

Figure 3 a photo of a cross section of a plasterboard according to Figure 1, and

Figure 4 a photo of a cross section of a further plasterboard.

The plasterboard according to figures 1 and 2 has a board core 1 to which a glass fiber layer 2 is attached on its one side which is provided on its outside with a calcium sulfate coating 3. The glass fiber layer 2 is divided in two layer-like regions 4, 5, whereas one region is filled with a coating mass which also forms the coating 3. The other region 5 is filled with a core mass which also forms the board core 1. The core mass and the coating mass are brought in contact with one another in the glass fiber layer along a separation plane 6.

The close contact between the core mass and the coating mass can be shown by means of pictures taken with a scanning electron microscope. Figure 3 shows the perfect contact of both layers which have penetrated the glass fiber layer. In the sheet plane shown in Figure 4, iron oxide has been added to the plaster of Paris before mixing. By means of the electron beam microprobe, it is determined to what extent the core mass has penetrated the glass fiber layer. As shown by the spectra, the core mass has penetrated the glass fiber layer up to the point depicted with "2". Point "1" shows no iron peak. Since in practice such analyses are too time-consuming, the extent of contact is characterized by the peeling strength.

The calcium coating 3 is a thin film coating and is at most 200  $\mu\text{m}$  thick. It is possible to see the structure of the glass fiber through the coating 3 since it is displayed as a thin coating on the glass fiber.

The equipment according to the drawing shows a sheet of the coated glass fiber 11 being pulled from a roll 10. The sheet advances over a die plate 12. From a mixer 13 gypsum core mass is poured on the coated glass fiber layer 11, which forms a hardenable board core 14 and also penetrates the coated glass fiber layer 11. Three transverse vibrators 15, 16, 17 extend over the breadth of the die plate 12 which engage at the coated glass fiber 11 from below. Furthermore, two edge vibrators 18 have been provided which engage at the two peripheral strips 19 of the coated glass fiber from below.

Figures 5 and 6 show how the mixer applies via several outlets 20 the gypsum paste to the coated lower glass fiber layer 11. The transverse vibrators 15, 16, 17 are provided one after another. They have a suction device 21 which extends transversely over the coated glass fiber layer 11. A pair of edge vibrators has been provided, each of which has a power unit 22. Next to the vibrators is a molding station 23, to which an upper, coated glass fiber sheet 24 is supplied and placed on the gypsum core mass sheet. Next to the molding station 23, two smoothing bars 25 have been provided.

According to Figure 7, gypsum core mass has been applied to the coated glass fiber layer 24, even in the region of the peripheral strips 26. The peripheral strips 26 form transition



regions 28 projecting beyond the peripheral strips 26 through a bending angle 27 of 90°. This is achieved by means of a guide rail 29 which are bending the transition regions 28 while the coated glass fiber layer keeps moving.

The device according to Figure 8 has a base plate 30 with a glass plate 31 lying on top of it and a supporting stand 32 at the edge. One arm of the supporting stand 32 carries a container 33 shaped like a truncated cone, which is closed on the bottom by a locking glass plate 34 which, in turn, is mounted to the supporting stand via a pivot arm. The gypsum paste to be tested is extracted from the mixer outlets 20 or when it flows on the sheet plane, is filled into the container 33 and withdrawn on top with a knife or a scraper. 15 seconds after the gypsum paste has been extracted, the lubricated locking glass plate 34 is quickly swiveled out at the mixer outlets so that the gypsum paste flows from the container 33 on the glass plate 31.